



REMARKS

Status of the Application

Specification

In response to the Examiner's July 26, 2005 comments concerning the Abstract, Applicants are canceling the Abstract at page 23, and adding a new Abstract set forth in the Replacement page 23 attached hereto. No new matter has been added.

Claims

Claims 1 has been canceled. Claim 2 has been amended and is an independent claim directed to method for painting a plastic substrate by applying a base coat directly to the plastic substrate and subsequently a clear coat is applied. The base coat comprises a binder selected from a polyurethane, an acrylated polyurethane, a polyacrylate, a polyester, an acrylated polyester or an alkyd resin. Claims 4 -11 have been amended and are dependent on Claim 2. Claim 3 has been amended and is an independent claim directed to the application of a monocoat top coat layer directly to a plastic substrate. The binder of the monocoat is defined as in claim 2. Claims 12 - 18 have been added and are directed to preferred embodiments of the process of Claim 3. Support for the amendment defining the binder is in the specification, page 6, lines 5-7. No new matter has been added to the claims.

Claim Rejections under 35 USC § 103

Claims 1-8, 10, 11 were rejected under 35 U.S.C. 103(a) as being unpatentable over Hellmann et al. U.S. 5,412,000 in view of Ozawa et al. U.S. 5,492,963. Hellmann was held to disclose the painting of plastic substrates but the coating disclosed by Hellmann as pointed out by the Examiner fail to teach the use of a chlorinated rubber which is a critical component of Applicants' invention. Ozawa was held to teach that chlorinated rubbers can be used for vulcanizing elastomeric adhesive

compositions which are not coating compositions as claimed in Applicants' process.

Applicants' invention is to the direct application of a base coat or a top coat to a plastic substrate without the use of a primer layer. Prior art compositions require the application of a primer layer to a plastic substrate to provide adequate adhesion to the plastic substrate and provide a layer to which subsequent coatings, such as, base coats or top coats are then applied. Applicants process is directed to the application of a base coat or top coat directly to the plastic substrate without the application of a primer layer which has heretofore not been possible. This is accomplished by using an adhesion promoting composition in the base coat or top coat as set forth in the amended claims. To be able to eliminate the primer layer of a multilayer coating as Applicants have done with their unique process is a significant advance in the art since reduces cost and decreases production time for coating plastic parts.

To understand Applicants' invention, basic terms used in the coatings art must be understood. One can not equate primers, base coats and top coats. Each perform a completely different function in a multilayer coating.

"Primer" is defined as "First complete coat of paint of a painting system applied to a surface. Such paints are designed to provide adequate adhesion to new surfaces and are formulated to meet the special requirements of the surface. The type of primer varies with the surface, its condition, and the total painting system to be used. "
(Paint/Coatings Dictionary Published by Federation of Societies for Coatings Technology, 1978, p 344).

To help the Examiner to understand terms of art used in the coating industry, the following two documents have been attached for the Examiner's review:

Automotive Paints and Coatings, Edited by G. Fettis, VCH publication (1st edition), pages 120 and 121 and

Ullmann's Encyclopedia of Industrial Chemistry (5th Edition, Vol. A, pp 517-519).

In the Automotive Paints and Coatings document, the various layers of a typical multi-layer automotive coating are set forth. As can be seen these various layers are clearly identified. In particular, Fig. 5-1 pictorially shows the various layers for a metal substrate and in particular, the primer layer, the primer surfacer layer and the basecoat and clear coat layers. For plastic substrates, a slightly different multilayer configuration is used. A primer layer is applied to the plastic substrate and then a topcoat layer or a combination of a base coat layer and a clear coat layer are then applied. A primer surfacer layer typically is not used. The primer layer provides adhesion to the plastic substrate and a smooth surface to which the top coat layer or base coat/clear coat layers can be applied. The basecoat layer is the color providing layer of the multi-layer coating which is not sanded or treated in any manner but is top coated with a clear protective layer. Similarly, the topcoat layer is the color providing layer which does not have a clear layer applied thereto. Each of the layers of a multi-layer coating have a special purpose and are significantly different from each other.

Ullmann, in par 11.2, similarly discusses multi-layer automotive paint coatings and shows multi-layer paint coatings used on automobiles comprise primers, intermediate coats (also called fillers or surfacers) and top coats which presently comprise a basecoat and a clear coat which is the most popular top coat used on automobiles today. The topcoat provides a full deep gloss (wet look), highly brilliant metallic effects long lasting resistance against weathering and chemicals and is easy to polish and repair.

Hellmann is directed toward primers that are applied to the plastic substrate. This is the layer that Applicants' process has been able to omit

by the use of a properly formulated topcoat or base coat layer. Since Hellmann is directed to primers, Hellmann uses epoxy resins as a binder component. Epoxy resins can not be used as topcoats or base coats since these resins are readily degraded by UV light. Applicants have amended the claims to used only binder components that are stable to UV light exposure and weathering. The binder components set forth in the claims are from the group of polyurethanes, acrylated polyurethanes, polyacrylates, polyesters, acrylated polyesters or alkyd resins and do not include epoxy resins.

Hellmann has to be overcoated as point out by the Examiner in the rejection of Claims 2 and 3. That is the point that must be understood. Hellmann is directed to a primer containing an epoxy resin that must be overcoated since it is not a durable topcoat finish. Furthermore, primers do not contain the pigments that are required to provide the desired colour to the painted plastic part. Applicants have eliminated the primer layer that is required by Hellmann.

Further, as recognized by the Examiner, Hellmann does not teach the use of a chlorinated rubber which is a necessary component of Applicants' composition used in the process as claimed. For this component, the Examiner reaches out to Ozawa to show that chlorinated rubbers are useful but Ozawa is directed to adhesive compositions not to coating compositions and in particular does not mention or suggest coating of plastics with a multilayer composition which is Applicants' invention as set forth in the amended claims.

Ozawa is directed to adhesives not coatings and has nothing to do with coatings. Ozawa is concerned with providing rubber to metal adhesives for bonding elastomeric materials, such as, vulcanized elastomers to metal surfaces. This adhesive field of technology is far from the technical field of the coatings art for application of multilayer coatings to plastics and is non-relevant art. Why would one skilled in the coatings art look to a reference to solve a coating problem that is not related to

coatings and contains no teachings or suggestions for the modification of coatings? To combine references as has been done there must be at least some motive to combine and here there is none.

Furthermore, the teaches of Ozawa have been interpreted completely wrong in the rejection. Ozawa teach that adhesive compositions based on chlorinated polyolefins having a chlorine content of 60% provide a better performance than traditional chlorinated rubbers (see Ozawa, col. 2 lines 3 – 8). This means that chlorinated polyolefins have been substituted for chlorinated rubbers and not the other way around. The chlorinated polyolefins according to Ozawa show better metal – wetting capability than commercial chlorinated polyolefins having a chlorine content of less than 60%. Nothing at all is taught by Ozawa of the fact that the use of chlorinated rubber leads to improved adhesion to plastics of coatings in comparison to the usual commercially available chlorinated polyolefins.

Even if Hellmann and Ozawa are combined, which is not suggested by either of the references, Applicants' invention is not taught or suggested since the resulting composition would contain an epoxy binder which can not be used for top coats or base coats. In the rejection the amended claims exclude the presents of epoxy resins in the binder. The Examiner has reconstructed Applicants' invention from the art using Applicants' own specification as a blue print which is an improper rejection and must be withdrawn.

Corcoran and Heaps only show waterborne compositions but not Applicants' invention and certainly can not be considered to be relevant references.

Applicants have amended the claims and have directed claims 2 and 4 – 11 to a process for the application of a base coat and clear coat directly to a plastic substrate wherein the binder of the base coat does not contain epoxy resins used in primers as taught by the cited art and only contains as a binder a polyurethane, an acrylated polyurethane, a

polyacrylate, a polyester, an acrylated polyester or an alkyd resin. A second group of claims, claims 3, 12 – 18 have been directed to a process for application of a monocoat directly to a plastic substrate wherein the monocoat and the base coat have been defined above. Also, Applicants have pointed out the patentable differences between the cited references of Hellmann and Ozawa and why these references are not combinable. The amended claims should be in allowable form and the application allowed.

SUMMARY

In view of the foregoing amendments and remarks, Applicants submit that this application is in condition for allowance. In order to expedite disposition of this case, the Examiner is invited to contact Applicants' representative at the telephone number below to resolve any remaining issues. Please charge any fee due which is not accounted for to Deposit Account No. 04-1928 (E.I. du Pont de Nemours and Company).

Respectfully submitted,

A handwritten signature in dark ink, appearing to read 'Hilmar L. Fricke', is written over a horizontal line.

Hilmar L. Fricke

Reg. No. 22,384

Attorney for Applicants

Phone: (302) 984-6058

Facsimile: (302) 658-1192

Date: November 17, 2005

PRIMARY COLORS, SUBTRACTIVE/PRINTING INK

tion with positive amounts, to avoid the use of negative amounts, which are required to match all colors when using real colored lights.^{43,69}

Primary Colors, Subtractive Colors of three colorants or colored materials which, when mixed together subtractively, result in black or a very dark neutral color. Subtractive primaries are generally cyan, magenta, and yellow, the three basic colorants used in printing, for example.^{69,43}

Primary High Polymer One which is produced directly from small molecules, without chemical alteration subsequent to the polymerization.¹³⁰
*See Derived High Polymer.*¹³⁰

Prime Pigments Pigments which possess colorant value and hiding power. The refractive index of these pigments is 2.0 or higher in contrast to extender pigments (q.v.).⁴¹

Primer (1) First complete coat of paint of a painting system applied to a surface. Such paints are designed to provide adequate adhesion to new surfaces and are formulated to meet the special requirements of the surfaces. The type of primer varies with the surface, its condition, and the total painting system to be used. Thus, primers for new wood and certain other surfaces must provide for exceptional absorption of the medium. Primers for steelwork contain special anti-corrosive pigments, such as red lead, zinc chromate, zinc powder, etc.⁷¹ *See Metal Primer; Plaster Primer.*⁷¹ (2) Coating applied to a surface, prior to the application of an adhesive, to improve the performance of the bond.¹⁵⁸(BSI)

Primer Surfacer *See Surfacer.*^{71,158}

Priming The application of a primer.¹⁵⁸(DAC)

Priming Paints *See Primer.*^{71,158}

Primrose Chrome Complex, primrose-colored chromates to which the formula $\text{PbCrO}_4 \cdot 4\text{PbSO}_4 \cdot \text{Al}_2(\text{OH})_6$ has been given.⁴¹

Print Name for etching, lithograph, woodcut, etc.⁸¹

Printability A collective term used to describe the properties required of all components in a printing process.¹⁶⁸

Printing (1) The process, art, or business of producing printed material by means of inked type and a printing press or similar means.¹⁶⁸ (2) Forming a permanent impression in a semihardened paint film as a result of pressure from an object placed on it.^{42,56,157}(DAC)

Printing Ink Any fluid or viscous composition of materials, used in printing, impressing, stamping, or transferring on paper or paper-like substances, wood, fabrics, plastics, films or metals, by the recognized me-

chanical reproductive process related services.¹⁶⁸(ASTM)

Printing Plate A surface carrying a pattern or design which is transferred to the material to be printed.

Printing Press A mechanical device used for transferring the pattern or design on the printing plate to the material to be printed.

Printing Strength A relative value which gives an equal depth of tint to a surface with the same amount of a standard colorant.

Print Resistance The ability of a surface to resist being marked by another surface placed against it.

Print Test *See Print Resistance.*

Process Inks Used in reproduction process. The colors used are cyan, magenta, and yellow (blue); they are used with or without a base.

Profile Surface contour of a body measured from the edge. (Cross section curve)

Profile Depth Average distance between the peaks and valleys on the surface of a coating.

Proof, Apparent The proof of a color at 60°F. It is equivalent to the proof of a color having the same specific gravity. Since materials other than the color itself are present in other soluble ingredients, apparent proof is not necessarily the same as true proof.^{164,128}

Proof Gallon, U. S. The amount of wine containing 50% by volume of alcohol at 60°F. It is equivalent to 128 wine gallons. For example, one wine gallon of 50% alcohol contains 64 proof gallons.^{164,128} *See Wine.*

Proofing The process of rubbing a color on a surface of water. It is an operation most commonly used for the removal of high viscosity or drying of a color and curing in dry heat.

Proof Spirit (Brit.) This corresponds to the amount of alcohol in water, and actually is Sixty-four overproof (O.P.) in

BEST AVAILABLE COPY

Automotive Paints and Coatings

Edited by Gordon Fettis

BEST AVAILABLE COPY



Weinheim · New York · Basel · Cambridge · Tokyo

1995

Professor Gordon Fentis
Department of Chemistry
The University of York
Healington
York YO1 500
United Kingdom

This book was carefully produced. Nevertheless, authors, editor and publisher do not warrant the information contained therein to be free of errors. Readers are advised to keep in mind that statements, data, illustrations, procedural details or other items may inadvertently be inaccurate.

1st edition 1995

Published jointly by
VCH Verlagsgesellschaft, Weinheim (Federal Republic of Germany)
VCH Publishers, New York, NY (USA)

Editorial Director: Dr. Barbara Böck, Louise Elsam
Production Manager: Dipl. Wirt.-Ing. (FH) Bernd Riedel

Library of Congress Card No. applied for.

A catalogue record for this book is available from the British Library

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Automotive paints and coatings / ed. by Gordon Fentis. -
Weinheim ; New York ; Basel ; Cambridge ; Tokyo : VCH, 1995
ISBN 3-527-28637-3
NE: Fentis, Gordon [Hrsg.]

© VCH Verlagsgesellschaft mbH, D-69451 Weinheim (Federal Republic of Germany), 1994

Printed of acid-free and low-chlorine paper

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form - by photoprinting, microfilm, or any other means - nor transmitted or translated into a machine language without written permission from the publishers. Registered names, trademarks, etc. used in this book, even when not specifically marked as such, are not to be considered unprotected by law.

Composition: Mitterweger Werkstatt GmbH, D-68723 Plankstadt
Printing: Strauss Offsetdruck, D-69509 Mörlenbach
Bookbinding: Wihl. Oswald & Co, D-67408 Neustadt
Printed in the Federal Republic of Germany.

5 Topcoats for the Automotive Industry

U. Poth

5.1 Definitions

Topcoats have as their main target to provide stability of the coating system against mechanical and chemical attack and to build an appealing effect. To fulfill all these aims, topcoats can consist of different layers. Whereas the traditional, so called solid colour topcoats consists of only one layer, today most of the metallic topcoats consist of two layers, the metallic basecoat and a clearcoat. Based on the experience with this two-layer system, there is a trend to apply solid colour topcoat systems in two layers as well. For special high quality topcoat systems there is the use of a solid colour precoat, which is applied before the topcoat to provide optimum smoothness and colour appearance. Usually, for the application of automotive coating systems there are three stoving processes: for the primer, the primer surfacer and the topcoat system. In the case of using a solid colour precoat four stoving times are required.

While the layer of primers for automotive coatings have a thickness of 18–23 μm (0.71–0.91 mils), the layer of primer surfacers have approx. 35 μm (1.38 mils), the solid colour topcoats have ca. 40 μm (1.57 mils), the metallic basecoats have 12–15 μm (0.47–0.59 mils) and the clearcoats have approx. 40 μm (1.57 mils), see Figure 5.1 [5.1].

Repair coats [5.2] are used for cars after any damage to the car body or in the case when an old coating system is no longer good in appearance or resistance. Repair coating systems consist of primers, primer surfacers, topcoats (in the special meaning of solid colour topcoats), basecoats and clearcoats ('after market repair'). The main difference between the OEM systems and the repair coats is the application method and more specifically the film building conditions. While the OEM topcoats will be stoved after spray application in tunnel ovens at temperatures of 120–150 °C (248–302 F) to build films with optimum properties, repair topcoats have to build resistant coat films at ambient temperatures or possibly at temperatures up to 60 °C (140 F). Therefore, the contents of repair coats are different to those of OEM coat systems.

If this damaging occurs during the coating process in the application line, the quality controller in the car plant can decide to run a repair coat application for a small part of the car or for the total car body. In the latter case the repair coat application will run under the same conditions as in the first coating process ('high-bake-repair' on line).

If any damage to the coated car body is observed in a later state of the car construction and it is necessary to repair the coating system, the application of a repair coat runs always at temperatures about 80–90 °C (176–194 F). For this so called 'low-bake-repair' a special coating system has to be used.

Solid colour	Metallic
Solid colour topcoat approx. 40 μm (1.57 mils)	Clearcoat approx. 40 μm (1.57 mils)
	Basacoat 12 - 15 μm
Primer/surfacer approx. 35 μm (1.38 mils)	
Electrocoat primer 18 - 23 μm (0.71 - 0.91 mils)	
Substrate: steel and inhibition layer	

Figure 5-1. Layers of automotive coating systems.

Additionally there is an increase of the use of plastic parts in the construction of car bodies.

Coatings for plastic parts are quite different from those for the steel parts of a car body (see Chapter 6). Plastic parts can not be heated to higher temperature without loss of properties. Therefore topcoats for these parts are applied separately from the car body and the conditions of film building are at lower temperatures, normally 60–80 °C (140–176 F) in some special cases higher (max. 120 °C, 250 F) [5.3]. Therefore topcoats for plastic parts are related to repair topcoats, but one has to achieve a much higher flexibility for this type of topcoat.

5.2 The Development of the Different Automotive Topcoat Systems [5.4] (see Chapter 1)

The coating materials of the first cars consisted of air drying binder systems based on vegetable oils and resins: rosin and copals. Copals are semifossil resins of trees which grew in the tropics [5.5]. In England, this coating technology, based on the combination of vegetable oils and copals in a hot blend process, was developed to a high quality. For the coating process 20 separately painted coat layers are required and up to 3 weeks work time. In the twenties the demand for automotive cars increased rapidly and production assembly lines were invented and developed. Topcoats based on cellulose nitrate as a film building vehicle were used. Cellulose nitrate was combined with plasticisers, and the coating systems which consisted of this combination performed fast drying at ambient conditions and had good appearance [5.6].

Ullmann's Encyclopedia of Industrial Chemistry

Fifth, Completely Revised Edition

Volume A 18:

Nucleic acids to Parasympatholytics and
Parasympathomimetics

Editors: Barbara Elvers, Stephen Hawkins, Gail Schulz

HERBERTS
Labor-Bibliothek

Inventor-Nr.:



1991

Numerical data, descriptions of methods or equipment, and other information presented in this book have been carefully checked for accuracy. Nevertheless, authors and publishers do not assume any liability for misprints, faulty statements, or other kinds of errors. Persons intending to handle chemicals or to work according to information derived from this book are advised to consult the original sources as well as relevant regulations in order to avoid possible hazards.

Production Director: Maximilian Montkowski

Production Manager: Myriam Nothacker

Editorial Assistants: Ilse Bodrich, Helen Goltz, Reinhilde Gutsch, Monika Pikart-Müller, Philomena Ryan-Bugler

Library of Congress Card No. 84-25-829

Deutsche Bibliothek, Cataloguing-in-Publication Data:

Ullmann's encyclopedia of industrial chemistry / ed.: Barbara Elvers ... [Ed. advisory board Hans-Jürgen Arpe ...]. — Weinheim ; Basel (Switzerland) ; Cambridge ; New York, NY : VCH.

Teilw. executive ed.: Wolfgang Gerhartz

Bis 4. Aufl. u. d. T.: Ullmanns Encyklopädie der technischen Chemie

NE: Gerhartz, Wolfgang [Hrsg.]; Elvers, Barbara [Hrsg.]: Encyclopedia of industrial chemistry

Vol. A. Alphabetically arranged articles.

18. Nucleic acids to parasymphatholytics and parasymphathomimetics. — 5., completely rev. ed. — 1991

ISBN 3-527-20118-1 (Weinheim ...)

ISBN 0-89573-168-1 (New York)

British Library Cataloguing in Publication Data

Ullmann's encyclopedia of industrial chemistry.

18. Nucleic acids to parasymphatholytics and parasymphathomimetics

I. Industrial chemistry

I. Elvers, Barbara II. Rounsaville, James F. III. Schulz, Gail

661

ISBN 3-527-20118-1

© VCH Verlagsgesellschaft mbH, D-6940 Weinheim (Federal Republic of Germany), 1991.

Printed on acid-free paper

Distribution

VCH Verlagsgesellschaft, P.O. Box 10 11 61, D-6940 Weinheim (Federal Republic of Germany)

Switzerland: VCH Verlag AG, P.O. Box, CH-4020 Basel (Switzerland)

Great Britain and Ireland: VCH Publishers (UK) Ltd., 8 Wellington Court, Wellington Street, Cambridge

CB1 1HZ (Great Britain)

USA and Canada: VCH Publishers, Suite 909, 220 East 23rd Street, New York NY 10010-4606 (USA)

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form — by photoprint, microfilm, or any other means — transmitted or translated into a machine language without written permission from the publishers.

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$ 1.00 per copy, plus \$ 0.25 per page is paid directly to CCC, 27 Congress Street, Salem, MA 01970. 0740-9451/85 \$ 1.00 + 0.25.

Registered names, trademarks, etc. used in this book and not specifically marked as such are not to be considered unprotected.

Cover design: Wolfgang Schmidt

Composition, printing, and bookbinding: Graphischer Betrieb Konrad Tritsch, D-8700 Würzburg

Printed in the Federal Republic of Germany

and second primers prevent corrosion of the metal surface. The pigments and extenders allow the primers to react with ions (Cl^- and SO_4^{2-}) that diffuse into the film from the atmosphere. The pigmented organic film also forms a barrier against humidity that may otherwise initiate a corrosive process.

Heavy-metal pigments (mainly lead pigments) and zinc chromates were used successfully in earlier decades. These pigments are now being replaced by nontoxic pigments (see Section 11.3.1, and \rightarrow Pigments Inorganic).

The first and second topcoats build up the necessary dry film thickness and protect the entire coated construction against the adverse influence of the atmosphere.

Binders based on linseed oil and other oils have been used for many years in anticorrosive primers. Alkyd binders, especially those with high fatty acid contents, perform similarly. The main disadvantages of these binders is their limited chemical resistance and their slow drying.

Chlorinated rubber and poly(vinyl chloride) (PVC) resins allow the formulation of coatings with good chemical resistance. They are therefore used for steel constructions in chemical plants. Since they are not resistant to many organic solvents, they should not be used in oil refineries or plants handling solvents. The undesirable fact that these binders contain halogens in high amounts is responsible for their decreasing use. Overspray of chlorinated rubber and PVC paints and contaminated blasting materials produced after removing old paint cause severe problems in waste incineration plants (generation of hydrochloric acid), as well as in waste disposal areas (pollution of soil and water).

Epoxy resins cured with aminoamide resins or amine adducts are often used for large metal constructions. Paints based on these resins are normally applied in four layers. Epoxy coatings form films that are resistant to organic solvents and a wide range of chemicals. Epoxy coatings are currently used for the majority of steel and aluminum constructions, but are also suitable for use on other construction materials (e.g., concrete). They can protect buildings in chemical plants and nuclear power plants. Epoxy coatings are less susceptible to deterioration by radiation than other organic films, and are also resistant to decontaminating chemicals (usually aqueous detergent solutions) used to remove radioactive dust from walls and other surfaces in nuclear power plants.

Heat-resistant coatings have silicone-resin binders. Pigments for such paints are zinc dust, flakes of aluminum or stainless steel, titanium dioxide, or silicon carbide. Such paints can withstand temperatures up to 600°C.

Paints with inorganic binders are also used for corrosion protection of steel constructions. These paints are based on organic silicates which are soluble in mixtures of alcohols or other water-miscible solvents (see Section 2.15.2). Ethyl silicate is often used and mostly pigmented with zinc dust. Zinc-rich primers and single coats are available as one- or two-pack products. Zinc-rich ethyl silicate paints dry to form inorganic films that are very durable even under adverse atmospheric conditions, (e.g., onshore and at sea). These coatings have excellent resistance to oil, solvents, and mechanical impact, and are therefore used on drilling stations, oil rigs, and ships. Since zinc-rich silicate coatings are heat resistant, they are also used in hot areas of iron works, coal mines, and coking plants.

Heavy-duty coatings are often still applied manually with brushes or rollers that completely wet the metal surface; holes and pores are filled with paint. This is especially important when old, partially rusted constructions are repainted after sanding. Brushing and rolling, however, only allow a slow working speed. Larger surface areas must be painted with airless spraying equipment.

11.2. Automotive Paints

11.2.1. Car Body Paints

Cars are coated to achieve maximum, long-lasting corrosion resistance. Cars must also be given an optimum appearance that lasts for many years. Long-lasting color and gloss retention as well as resistance against cracking (especially in clearcoats of two-coat metallics) are therefore necessary. Topcoats of automobiles must withstand solar radiation and atmospheric pollution (e.g., acid rain and soot from oil combustion). Aggressive chemicals (e.g., road salts and cleaning agents containing detergents) can damage the coating if they come into contact with the car surface. Furthermore, small stones cause heavy impact on automobile surfaces and corrosion via chipping.

Large numbers of cars are manufactured on fast-running assembly lines. The paints must

therefore be applied with highly efficient equipment, and must dry very quickly. The paint products are classified as primers, intermediate coats (also called fillers or surfacers), and topcoats (or finish). The primers and fillers are designated as the undercoating system.

Car paints are cured with heat in special oven lines. Electrodeposition coatings (used as anticorrosive primers) contain only small amounts of volatile organic compounds (VOC), whereas intermediate and topcoats release considerable amounts of VOCs. Intermediate coats based on waterborne resins have been developed to decrease VOC emission and are already being used in some automotive plants. Basecoats, as part of base-clear topcoat systems, contain very high amounts of volatile organic solvents. Waterborne basecoats were developed more recently to lower this source of solvent emission. Some car manufacturers are operating pilot lines with the aim of introducing waterborne basecoats into their production processes. Many car producers in the United States and Europe have already switched their topcoat lines over to waterborne basecoats [11.3].

Pretreatment. Various metals are used for manufacturing car body shells: steel, galvanized steel, aluminum alloys, and zinc-rich precoated steel. The surfaces of these metals are routinely contaminated with oils, drawing lubricants, dirt, and assembly residues (e.g., welding fumes). The body shells are pretreated to remove these contaminants and to obtain a well-defined, homogeneous surface that has the necessary properties for adhesion of primers. Pretreatment includes surface cleaning and formation of a phosphate conversion coat on the shell surface (see Section 8.2.1); six to nine discrete steps are involved using either spraying devices or baths. Continuous control of phosphating solutions ensures good results [11.1], [11.4].

Anticorrosive Primers. Anticorrosive primers are applied in dip tanks so that they reach all parts of the car body; dipping is a fast method of application. The standard method for application of primers is electrodeposition. Anodic electrodeposition paints were used when the electrocoating technique was first applied, but cathodic electrodeposition is now predominant because it provides better corrosion protection.

The binders for cathodic electrodeposition are epoxy resin combinations dispersed in water (see Section 3.8). Advantages of anticorrosive electrocoatings include excellent corrosion resistance at a dry film thickness of ca. 20–30 μm . Electrocoats are stoved at 165–185°C to obtain films with the desired properties. The paint industry is now developing electrocoats that can be cured at lower temperatures (140–150°C). Electrocoating produces a homogeneous film that covers the entire car body surface, including recesses and cavities.

Although the dry film thickness on the metal edges is somewhat lower, these areas are still efficiently protected against corrosion. The ultrafiltration technique results in a very high transfer effect and a uniform coating: paint solids from the bath are deposited on the metal surface without loss. Since electrodeposition paints have a low organic solvent content, air pollution is low. The dip tank contents are not flammable, which reduces insurance costs [11.5].

Intermediate Coats. Intermediate coats (fillers) are applied between the anticorrosive primers and the topcoat systems. They provide good filling and flowing layers which are normally smoothed by sanding. Oil-free polyesters are used as binders for fillers. They react with blocked isocyanates in 20 min at 165°C. Their high flexibility gives the whole coating system a highly effective mechanical (stone chip) resistance.

Fillers are applied with electrostatic spraying devices (fast-rotating bells) to give dry film thicknesses of about 40 μm . Waterborne fillers with polyester-melamine binders (primer surfacers) have been developed to reduce the volatile organic content. They yield a film thickness of 30 μm after a prereaction time of 10 min at 100°C and a reaction time of 20 min at 165°C. The properties of the films are similar to those formed by solventborne paints. More recently, waterborne fillers based on blocked isocyanates have been developed. Field trials have shown that their mechanical resistance is very good.

Topcoat Systems. Topcoats form an important part of the protection system of the car body surface, but are much more important for decoration. The basic requirements for a car topcoat are:

- 1) Full, deep gloss (wet-look)
- 2) Highly brilliant metallic effects
- 3) Long-lasting resistance against weather and chemical influences
- 4) Easy to polish and repair

Topcoats based on nitrocellulose combinations with plasticizers and alkyd resins were used in the first decades of industrial car manufacturing. These were followed by thermosetting alkyd-melamine combinations, and later by thermosetting acrylics. The use of stoving enamels as thermosetting paints also accelerated production significantly. Although the properties of these coatings during application and in use were very good, their high content of volatile organic solvents had to be lowered to comply with legal restrictions.

The basecoat-clearcoat system is presently the most commonly used type of topcoat for cars because it is the standard application system for metallic colors. Today, about 70% of all cars have metallic topcoats. The basecoat-clearcoat system consists of a colored layer (basecoat) which is overcoated after a short flash-off time with a protective layer of clearcoat. Both coats are cured together at 120–140°C. The basecoat contains pigments which provide two types of finish: solid (straight) colors or metallic.

Solventborne metallic basecoats contain ca. 15% solids and ca. 85% volatile organic solvents. These solvents are not released into the atmosphere, but are converted to combustion gases in afterburners. To reduce emission of organic solvents from this source, waterborne basecoats have been developed.

Waterborne basecoats with higher solids contents are now available: metallic basecoats contain about 18 wt % solids and solid (straight) color basecoats 25–40 wt %. The solvent in waterborne paints is not pure water; about 15% of organic solvents is still needed as a cosolvent for proper film formation. Metallic basecoats are applied at a DFT of 15 µm, solid color basecoats at a DFT of 20–25 µm.

Basecoats are sprayed in two layers. The first layer is sprayed electrostatically with high-speed rotation bells, the second layer is sprayed with compressed air to achieve proper orientation of the aluminum particles in metallic paints. The basecoat is then dried for 3–5 min in a warm air zone at 40–60°C.

A final layer of clearcoat is applied with electrostatic high-speed rotation bells [11.3], [11.7]

to protect the system against atmospheric influences, including wear and tear during use.

Alkyd-melamine clearcoats with an approximate solids content of 50% contain UV-absorbing agents to prevent deterioration in extreme climates.

Some car manufacturers use clearcoats with acrylic binders that are cured with aliphatic isocyanates. Their chemical and mechanical properties are better than those of alkyd-melamine clearcoats. Solid contents are as high as 58%.

Car Repair Paints [11.1]. Repair paints are used in considerable amounts for refinishing cars. Since repair shops cannot provide the same facilities as those of car manufacturers, repair paints are dried at ambient temperature or elevated temperature up to 80°C (metal temperature). Alkyd repair paints and nitrocellulose paints were standard materials, but two-pack acrylate-isocyanate refinish paints are now more common. Their properties are similar to those of the original car coatings (long-lasting gloss and color, mechanical and fuel resistance). Car refinish paints are available in a wide range of colors, solids as well as metallics. They are often supplied to shops and retailers as mixing schemes.

Paint systems for car repair comprise anticorrosive primers, putties, intermediate coats, and topcoats; repair coatings applied to refinished cars have similar durabilities to those of the originally manufactured coating systems.

11.2.2. Other Automotive Coatings

The properties of coating systems used for car components differ considerably from those of systems used for exterior car surfaces. Color is not important (and is mainly black or gray), but anticorrosive properties similar to those of car body coatings are required. Since car components are produced in large numbers, coatings are commonly baked at high temperature to ensure a high reaction rate and rapid film formation.

Wheels are electrocoated; engine blocks are coated with heat-resistant, usually waterborne materials. Other parts (e.g., steering equipment and shock absorbers) are painted with two-pack, one-coat epoxy systems that are usually solventborne; use of waterborne systems is, however, increasing.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☒ **BLACK BORDERS**

☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**

☐ **FADED TEXT OR DRAWING**

☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**

☐ **SKEWED/SLANTED IMAGES**

☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**

☐ **GRAY SCALE DOCUMENTS**

☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**

☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**

☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.